# The Relationships between Clothing and Equipment and Performance/Injury: The Trident Approach to Research

Orr, Rob Marc

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# The Relationships between Clothing and Equipment and Performance / Injury:

## The Trident Approach to Research

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# Tactical Research Unit

## Dr Rob Orr



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## MISSION

To enhance the protection and performance of tactical personnel through pragmatic research, education and advice.

## VISION

Excellence in research that will lead to improvements in the health, wellbeing and occupational performance of tactical personnel.

https://bond.edu.au/tru

# Load Carriage

* The loads have changed (Firefighters)

# Load Carriage

* The loads have changed (Law enforcement)

# Load Carriage

* The loads have changed (Military)

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# LAND 125-4

- Academia – Bond University
- Industry – Connexxion

SOLDIER LOAD EVENT

**PSRT Results Prediction Formula**[*3]

VO2 ml.kg.min= 3.46 * (Level + stage / (Level * 0.4325 + 7.0048)) + 12.2

**2.4 km Run Time Prediction Formula**[*4]

VO2 ml.kg.min = (483 / time) + 3.5

Fitness VO2 l.min$^{-1}$ = W*VO2 ml.kg.min/1000

Workload VO2 l.min$^{-1}$ = M/20.41*60/1000

%VO2 l.min$^{-1}$ = (Workload VO2 l.min$^{-1}$/ Fitness VO2 l.min$^{-1}$) * 100

**Load Carriage Task Workload Formula (Pandolf [*1] *with Givoni & Goldman load placement*[*2])**

$$M = 1.5\,W + 2.0\,(W + L)(L/W)^2 + \eta(W + L)[1.5\,V^2 + 0.35\,VG] + V^2(0.015L_H^2 + 0.064L_F^2)$$

Soldier's Body Weight (kg)

= W

TOTAL External Load Weight (kg)

= L

External Load Weight in Hands (kg)

= $L_H$

External Load Weight on Feet (kg)

= $L_F$

Walking Speed (m/s)

= V

Terrain Grade (%)

= G

**Terrain Type**

= η

1.0 = tarred road,
1.1= dirt road;
1.2 = light brush,
1.5 = heavy brush,
1.8 = swampy bog,
2.1=loose sand

*1 = Pandolf et al., (1977)

*2 = Givoni & Goldman (1971)

*3 = Ramsbottom et al., (1988)

*4 = ASCM Coopers 1.5 mi (recommended by Jace from DSTG)

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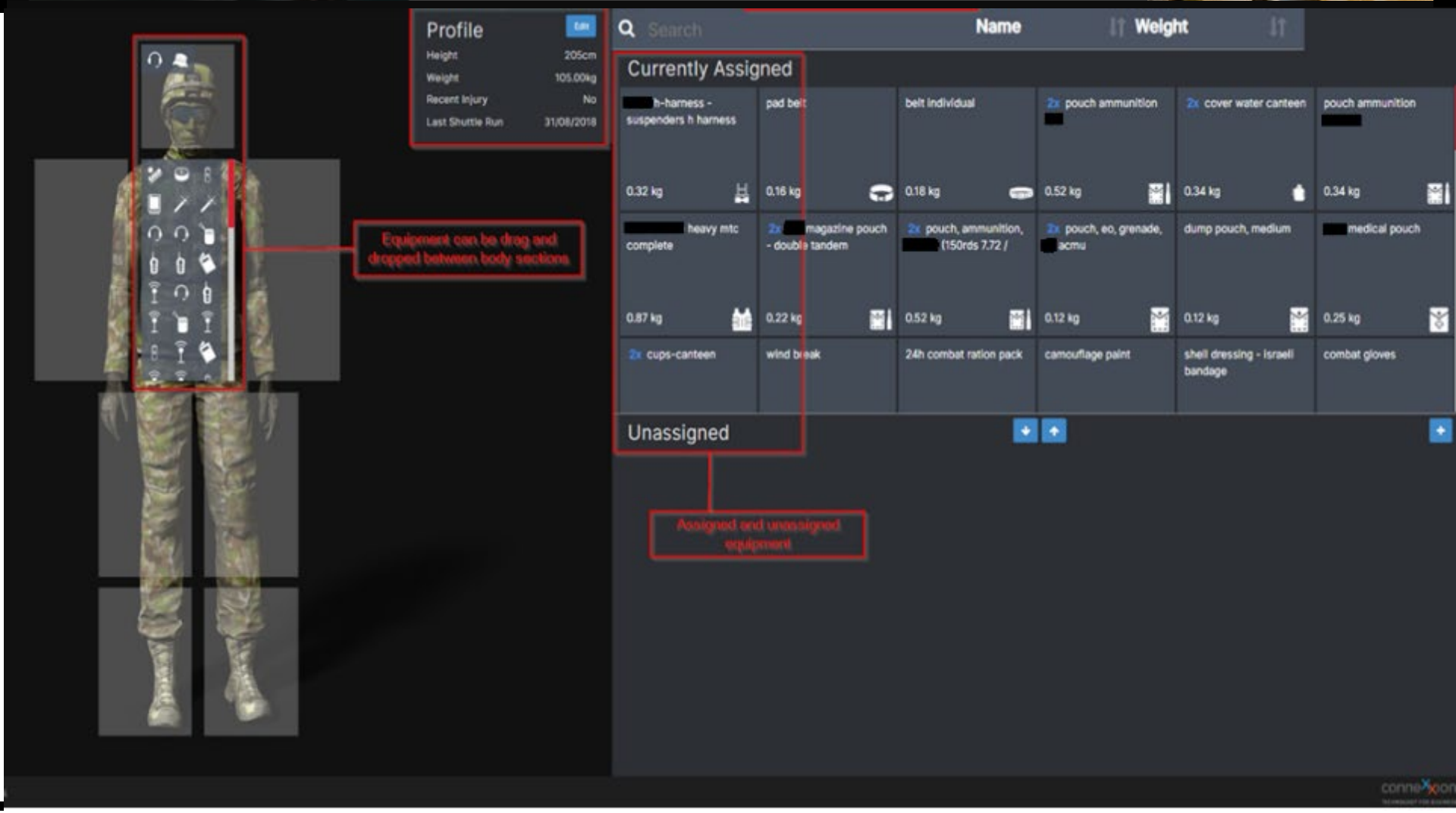

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Army | ATLAS | Dashboard | Profile | Loadout | Events | Administration | Mail | john.fenton

← Back to Events List

Kamaria March

Start Date: 01/09/2018 End Date: 03/09/2018 PESA 1

Terrain: Tarred Road | Velocity: 5.50 km/h

Grade: 0.00 % | Target Burden: 30 kg

Save Changes

Add New Fireteam

Event details

## Team 1

Add Members | Remove Fireteam

| PTE Sean Martin | LCPL John Fenton | PTE Sam Babic | PTE Andrew Creaner |
|---|---|---|---|
| Risk: Medium 14 | Risk: Low 17 | Risk: Medium 16 | Risk: Medium 13 |
| Burden: 33.82% (28.75kg) | Burden: 27.38% (28.75kg) | Burden: 31.94% (28.75kg) | Burden: 35.94% (28.75kg) |
| View Loadout | View Loadout | View Loadout | View Loadout |

Burden Overrides — Reset

| | |
|---|---|
| PTE Sean Martin | 28.75 kg |
| LCPL John Fenton | 28.75 kg |
| PTE Sam Babic | 28.75 kg |
| PTE Andrew Creaner | 28.75 kg |

Short term mission, carrying 30kg

Different risk values for section members with different levels of fitness

## Team 2

Add Members | Remove Fireteam

| PTE Andrew Reisinger | PTE Anthony Franzi | PTE Chris Lee | PTE Shahan Mafuz |
|---|---|---|---|
| Risk: Medium 13 | Risk: Medium 14 | Risk: Substantial 9 | Risk: Medium 12 |
| Burden: 38.33% (28.75kg) | Burden: 33.82% (28.75kg) | Burden: 35.06% (28.75kg) | Burden: 44.23% (28.75kg) |
| View Loadout | View Loadout | View Loadout | View Loadout |

Burden Overrides — Reset

| | |
|---|---|
| PTE Andrew Reisinger | 28.75 kg |
| PTE Anthony Franzi | 28.75 kg |
| PTE Chris Lee | 28.75 kg |
| PTE Shahan Mafuz | 28.75 kg |

Army Courage Initiative Respect Teamwork

# BODY ARMOUR

- Academia
- Industry
- SME

Local law enforcement

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Tomes *et al. Annals of Occupational and Environmental Medicine* (2017) 29:14
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Annals of Occupational and Environmental Medicine

RESEARCH ARTICLE Open Access

# The impact of body armor on physical performance of law enforcement personnel: a systematic review

Colin Tomes[1,2], Robin Marc Orr[2*] and Rodney Pope[2]

**Abstract**

**Background:** The law enforcement officer profession requires performance of arduous occupational tasks while carrying an external load, consisting of, at minimum, a chest rig, a communication system, weaponry, handcuffs, personal protective equipment and a torch. The aim of this systematic review of the literature was to identify and critically appraise the methodological quality of published studies that have investigated the impacts of body armour on task performance and to synthesize and report key findings from these studies to inform law enforcement organizations.

**Methods:** Several literature databases (Medline, CINAHL, SPORTDiscus, EMBAS) were searched using key search words and terms to identify appropriate studies. Studies meeting the inclusion criteria were critically evaluated using the Downs and Black protocol with inter-rater agreement determined by Cohen's Kappa.

**Results:** Sixteen articles were retained for evaluation with a mean Downs and Black score of 73.2 ± 6.8% (k = 0.841). Based on the research quality and findings across the included studies, this review determined that while effects of body armour on marksmanship and physiological responses have not yet been adequately ascertained, body armour does have significant physical performance and biomechanical impacts on the wearer, including: a) increased ratings of perceived exertion and increased time to complete functional tasks, b) decreased work capability (indicated by deterioration in fitness test scores), c) decreased balance and stability, and d) increased ground reaction forces.

**Conclusions:** Given the physical performance and biomechanical impacts on the wearer, body armour should be carefully selected, with consideration of the physical fitness of the wearers and the degree to which the armour systems can be ergonomically optimized for the specific population in question.

**Keywords:** Officer, Police, Body armour, Personal protective equipment

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# FIRE FIGHTER PPE

- Academia
- Industry
- SME Local Australian Fire Service

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# A Profile of Injuries Sustained by Firefighters: A Critical Review

**Robin Orr[1,2,*], Vini Simas [1,2], Elisa Canetti[1,2] and Ben Schram[1,2]**

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[2] Tactical Research Unit, Bond University, Gold Coast, QLD 4229, Australia
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Submitted

**Abstract:** Firefighters are at a high risk of work-related physical injury above that of the private sector. The aim of this critical narrative review was to identify, critically appraise and synthesize key findings from recent literature investigating firefighting musculoskeletal injuries. The methodological approach (search terms, databases, etc.) was registered with PROSPERO and reported following the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) guidelines. Study quality were assessed using the Downs and Black checklist with scores and graded according to the Kennelly grading system. Levels of evidence were ranked according to the Australian National Health and Medical Research Council. Of the 8231 studies identified, 17 met the criteria for inclusion. The methodological quality of the studies was 'fair' with a level of evidence of III-2. Reported injury rates ranged from 9-74% with the lower extremities and back the leading aggregated bodily sites of injury. Sprains and strains were the leading nature of musculoskeletal injury, often caused by slips trips and falls, although muscle bending, lifting and squatting or muscle stressing were also prevalent. Firefighter injuries are similar to those of other tactical populations. Safety processes to mitigate these injuries may be of benefit across the tactical spectrum.

**Keywords:** fireman; firefighter; injury; tactical; occupational health

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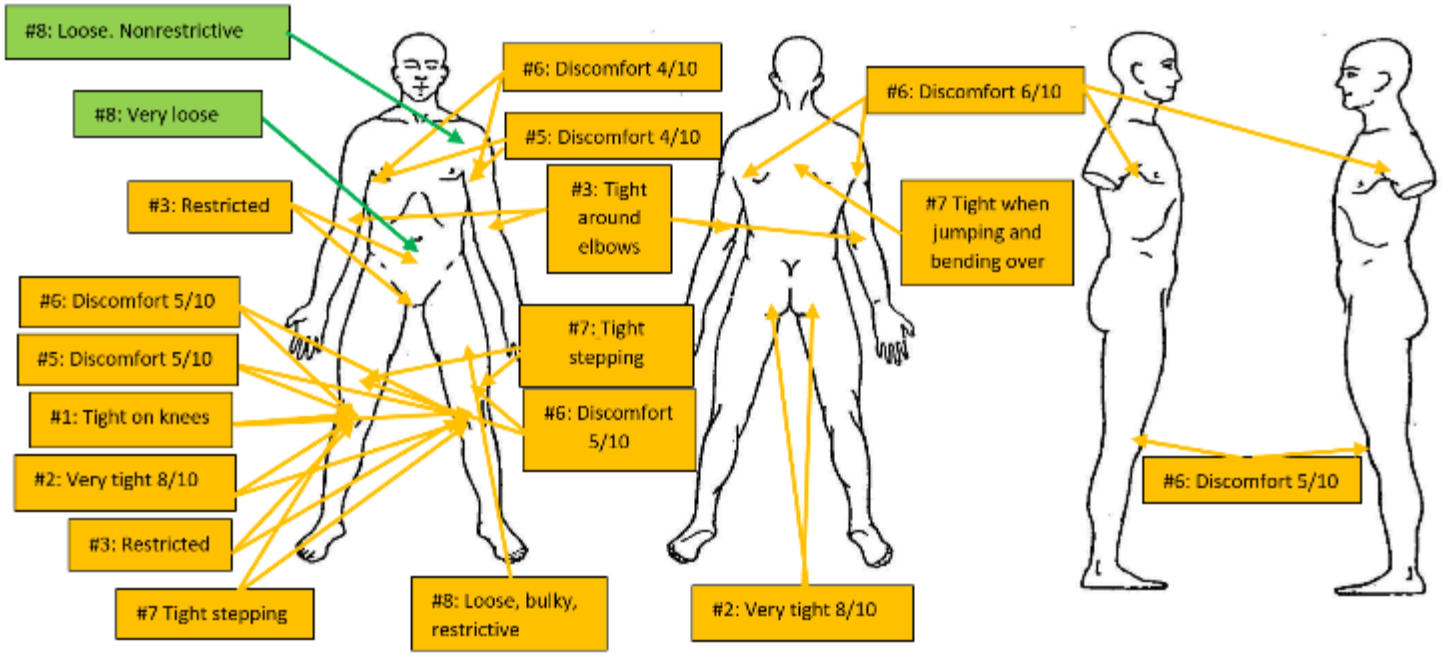
Negative Feedback

Positive Feedback

Neutral Feedback

#3: Restricted in legs



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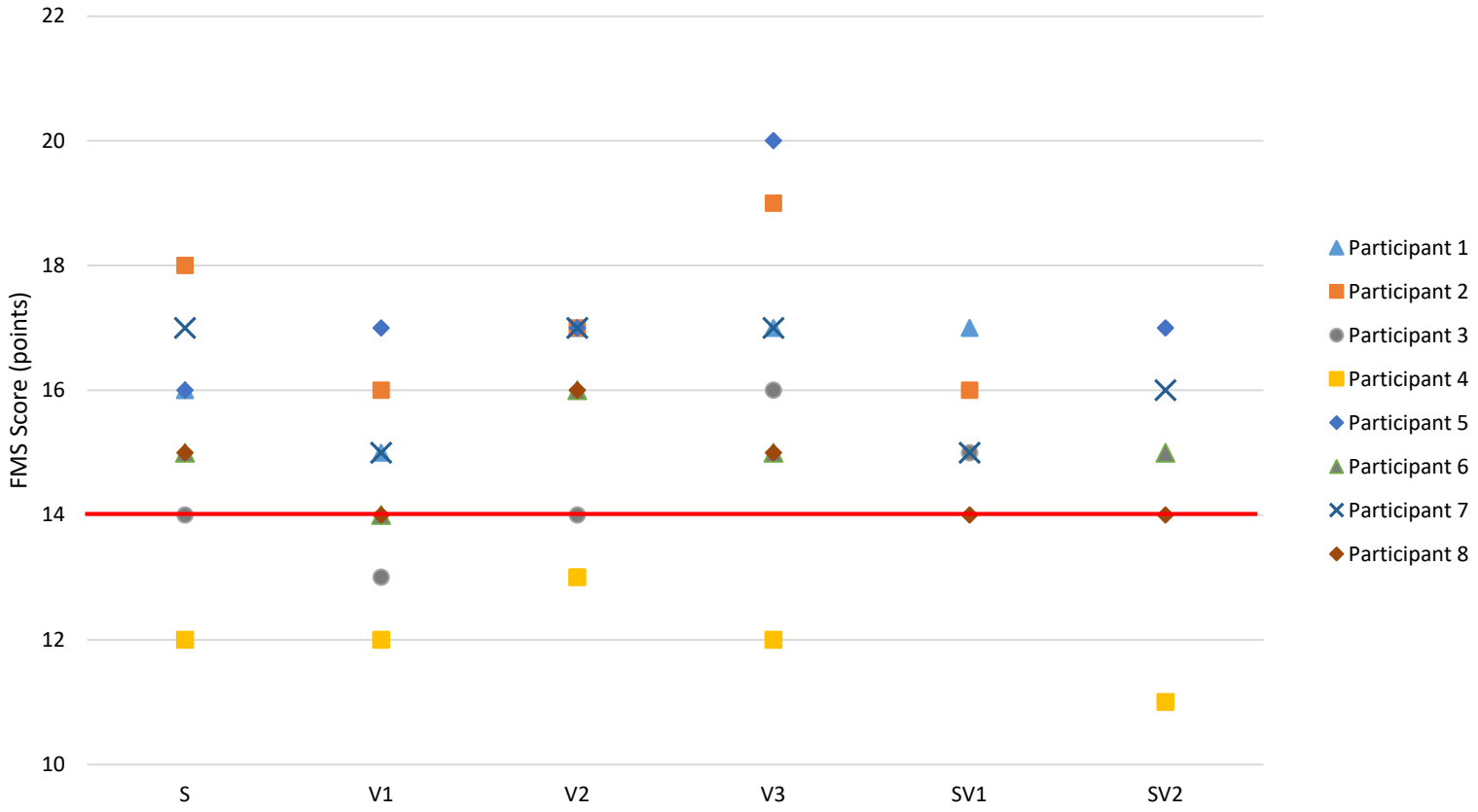
## Total FMS Score per participant



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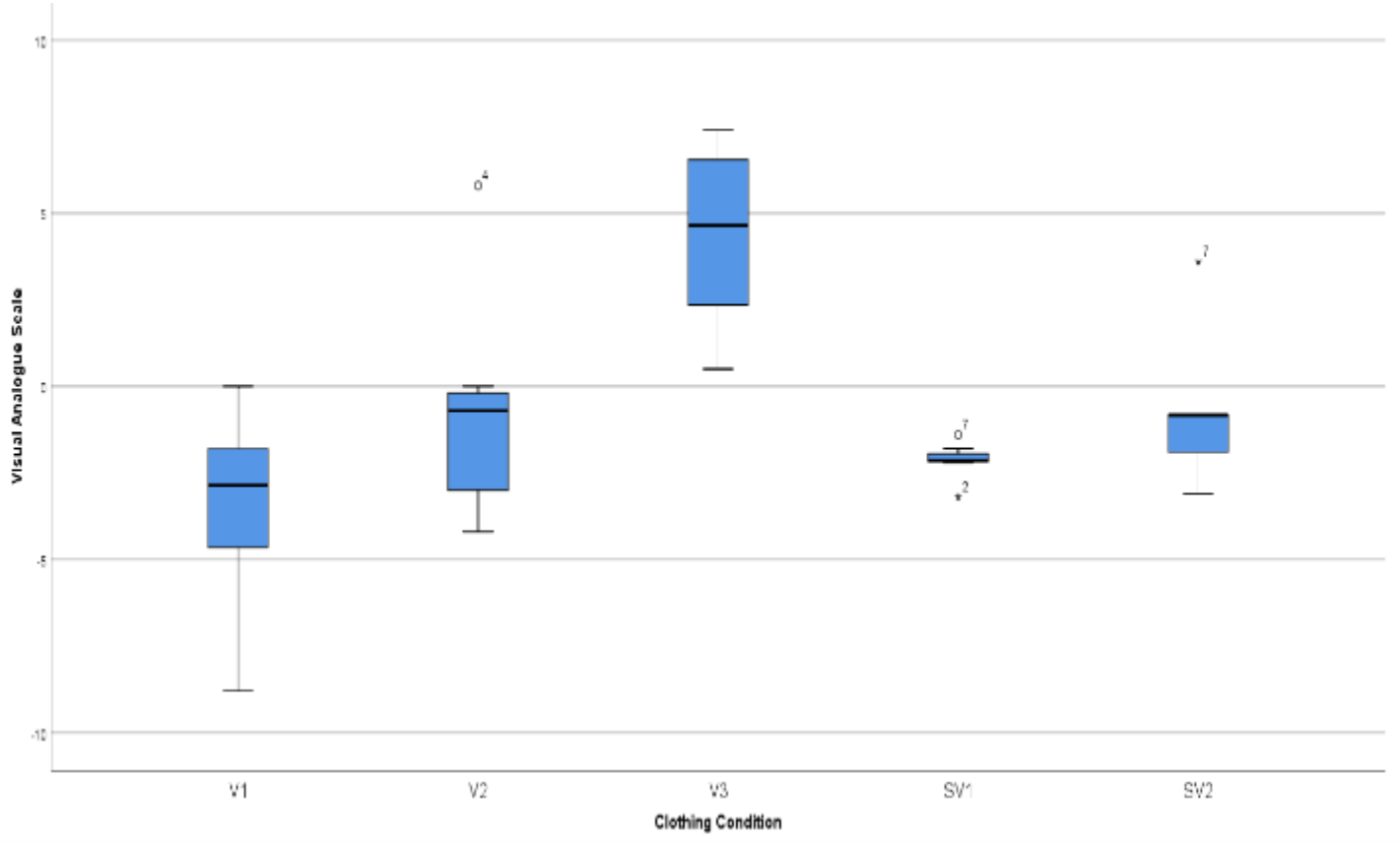
## Subjective results of the FMS when compared to station wear



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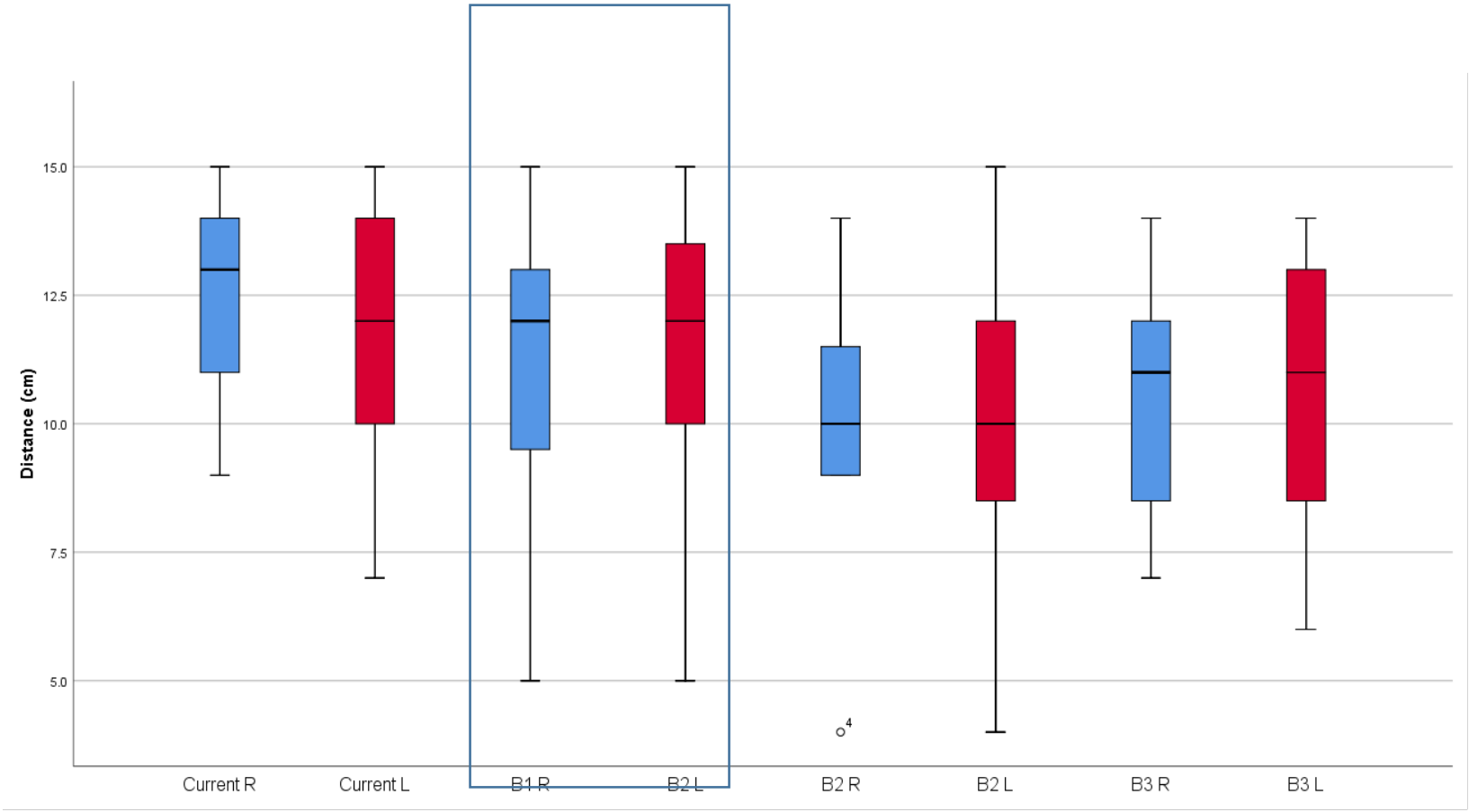

# Initial Findings

- Not only does firefighter PPE impact on their mobility
  – but different configurations may impact on their mobility differently
- Different firefighter occupations have different movement requirements, but their clothing has different limitations AND their patterns of injuries are different

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# Thank you

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